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# FRANKFORD ARSENAL

## TECHNICAL MEMORANDUM

M53-22-1



EXAMINATION AND EVALUATION

OF

CANADIAN AIMING CIRCLE

BY W. W. HOLLIS

Fire Control Instrument Group

FRANKFORD ARSENAL

PHILADELPHIA, PA.

27 MAY 1953

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Research and Development Division  
Ground Weapons Department  
Fire Control Instrument Group  
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EXAMINATION AND EVALUATION  
OF  
CANADIAN AIMING CIRCLE

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## EXAMINATION AND EVALUATION OF CANADIAN AIMING CIRCLE

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### I. AUTHORITY

This report is prepared under authority contained in letter file OO 413.68/565, Subject: Canadian Aiming Circle, dated 14 November 1952 and is a part of Ordnance Project TR5-5009.

### II. INTRODUCTION

1. The Optical Design Branch, R&D Division, Ground Weapons Department, FCIE has been assigned the responsibility for the study and evaluation of the Canadian Director, Artillery No. 7, Mk 4. This report is the result of that study.

2. An attempt has been made to discuss the desirable and objectionable features of the Canadian Instrument and to compare it with the standard Aiming Circle M1. In areas where the Aiming Circle T3 differs in essential features from the M1, comparison of the Canadian Aiming Circle has been made with the Aiming Circle T3 as well.

3. The figures included in this report are copies of those found in Canadian Army Local E.M.E. instructions entitled, Directors No. 7, Description and Theory.

### III. DISCUSSION

1. The base of the instrument (fig. 3) is drilled and tapped to accommodate the clamping screw of the stand or tribrach and is also provided with three "V" shaped grooves spaced approximately 120° apart which fit over the positioning studs on the stand.

2. The lower motion, controlled by a worm and wheel, is provided with a quick release lever which disengages the slow motion spindle and allows the instrument to slew rapidly in azimuth. (Figure 4)

3. The azimuth scale (fig. 5) is pivoted on the base. The scale is graduated every degree and numbered every ten degrees from 0 to 350.

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4. The body of the instrument pivots about the azimuth scale and is provided with two index marks  $180^{\circ}$  apart for reading the azimuth scale. One of these marks, located under the eyepiece of the telescope, is black; the other, located under the objective, is red. The upper motion of the instrument is controlled by a worm and wheel (fig. 7). Fine motion is provided by means of a micrometer drum graduated every two minutes and numbered every ten minutes. The upper motion is provided with a throw out mechanism for slewing. One complete revolution of the spindle moves the director through  $2^{\circ}$ . The compass needle is viewed through a plane window. The compass is adjustable to compensate for varying magnetic declination. The needle may be lifted from its pivot, when the compass is not in use, by means of a spring loaded plunger.

5. The telescope (fig. 9) open sight, level bubble and elevating mechanism are carried on trunnions which are part of the body. The telescope is 4.5 power with a field of view of  $12^{\circ}$ . The eyepiece is inclined at an angle of 50 degrees with the line of sight of the objective. Elevation is provided from plus 65 degrees to minus 15 degrees. The telescope is provided with an eye shield, weather shield and a neutral filter. The reticle is divided into four quadrants by two cross lines and the axes are graduated in degrees from 0 to 6 degrees in each direction and subdivided into ten minute increments. The elevating gear is operated by means of a spindle fitted on one end with a micrometer drum which is read against an adjustable index. The elevation scale is graduated from 15 degrees depression to 65 degrees elevation. One turn of the spindle is equivalent to 5 degrees. The micrometer is numbered every degree, : black for elevation, red for depression.

6. The following table shows a comparison of the main physical characteristics of the Canadian Instrument and the Aiming Circle M1:

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<u>No.</u>	<u>Item</u>	<u>Aiming Circle M1</u>	<u>Canadian Aiming Circle</u>
1	Diameter	5 inches approx.	5.5 - 6 inches approx.
2	Height *	4.25 inches	9.5 inches approx.
3	Weight	4 pounds	5.6 pounds
4	Coaling *		
	a. Telescope	Yes (modified M1)	Yes
	b. Mechanical Assembly	No	Partially
5	Winterized	Yes	Yes
6	Leveling *	Ball & Socket on tripod	Three point leveling of instrument
7	Sighting Aid *	4x Telescope	4.5x Telescope with inclined eyepiece
8	Compass *	Yes	Yes
9	Leveling Indicator	Yes	Yes
10	Azimuth Scale	0-6400 $\mu$ (external)	0-360° (external)
11	Azimuth Scale Mechanism	Fine and coarse motion thru worm and wheel	Fine and coarse motion thru worm and wheel
12	Elevation Scale *	No	Yes
13	Elevation Scale Mechanism *	—	Fine motion controlled by worm and wheel
14	Orienting Mechanism	Fine and coarse motion thru worm and wheel	Fine and coarse motion thru worm and wheel
15	Protection of scale mechanism	Yes	Yes
16	Backlash	Errors affect accuracy	Errors affect accuracy
17	Main Bearing	Tapered (friction type)	Tapered (friction type)

\* The starred items in the above paragraph will be compared in the following table with the same features of the Aiming Circle T3.

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No.	Item	Aiming Circle T3	Canadian Aiming Circle
2	Height	8-11/16 inches	9-1/2 inches
4	Scaling *		
	a. Telescope	Yes	Yes
	b. Mechanical Assembly	Partially	Partially
6	Leveling	Three point leveling on instrument	Three point leveling on instrument
7	Sighting Aid	4x telescope with inclined (45°) eyepiece	4.5x telescope with inclined (50°) eyepiece
8	Compass	Yes, insensitive to dip	Yes, adjustable for declination
12	Elevation Scale	minus 400 to plus 800'	minus 15 to plus 65°
13	Elevation Scale mechanism	Fine motion thru worm and wheel	Fine motion thru worm and wheel

\* Possibility of dust entering these instruments at boundaries of rotating portions.

7. There are one or two minor differences between the Canadian Instrument and the Aiming Circle T3 which are worthy of note.

a. The Aiming Circle T3 is fitted with hinged caps to protect the lower motion adjustment once a correct setting is obtained. This feature is not found on the Canadian Instrument.

b. Conical shaped micrometer drums are utilized on the Canadian Aiming Circle as opposed to cylindrical drums on the Aiming Circle T3. It is supposed that conical shaped drums provided for greater ease in scale reading.

c. It is pointed out that all scales of the Canadian Aiming Circle are graduated in degrees and minutes whereas standard practice for our instruments is to graduate all scales in mils.

8. The leveling screw knobs on the Canadian Aiming Circle are small (1-3/16 in. diameter) and may be of such a size as to cause difficulty in use where the operator may be attired in artic gear.



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9. The major disadvantage found in the design features of the Canadian Aiming Circle is connected with its tapered main bearing. The main bearing of the Canadian Aiming Circle is split in such a manner that the tapered shaft carries two separate tapered sleeves, one above the other. These two sleeves must be accurately fitted to the shaft and seated with respect to each other in order to insure the proper meshing of the upper worm gear with respect to its wheel and the lower worm gear with respect to its wheel. In practice, the lower sleeve is fitted to the shaft and adjusted so that the action of the lower worm and wheel is correct. After this is accomplished, the upper sleeve must be fitted to the shaft and seated on top of the lower shaft so that the upper worm and wheel mesh correctly and so that no binding is caused between the upper and lower sleeves under rotation. This procedure requires an instrument assembler of high skill. The main bearings of the M1 and T3 are such that one sleeve must be fitted to the tapered shaft and adjusted for the gear mesh. The tapered shaft which is hollow then is fitted to a straight bearing and adjusted for the correct mesh of the lower motion worm gear and wheel.

### IV. CONCLUSIONS

1. It is concluded that in most particulars the Canadian Aiming Circle is similar to the Aiming Circle M1 and in physical size and shape much the same as the Aiming Circle T3.

2. It is concluded that the tapered bearing present in the instrument is an objectionable feature not only because of the difficulty in assembly and adjustment, but also because of a general tendency of tapered bearings to "lock up" under conditions of extreme cold. It is pointed out in passing that present practice is to eliminate tapered bearings wherever possible.

3. The scale graduations of the Canadian Aiming Circle being in degrees and minutes are unsuited for use by Army Field Forces.

4. It is concluded, finally, that, if the scale graduation were in mils, the Canadian Aiming Circle would serve the purposes of the Army Field Forces but it would represent no improvement over those instruments presently in use or proposed for use.

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1. Eyeguard	12. Closing cap, telescope bubble
2. Securing ring, eyepiece cell	13. Open sight, rear
3. Graticule window, illuminating	14. Bubble B, telescope
4. Rainshade	15. Housing, elevating arc
5. Body level, circular, Mk. 2	16. Recording plate, compass deviation
6. Spindle cap, adjusting compass variation	17. Scale plate, elevation
7. Milled head, worm gear, No. 2	18. Micro drum
8. Plunger, compass release	19. Scale, azimuth
9. Knurled head, elevation	20. Securing lugs, base supporting
10. Fluted head, worm gear, No. 1	21. Base, supporting.
11. Levelling screw, base supporting	

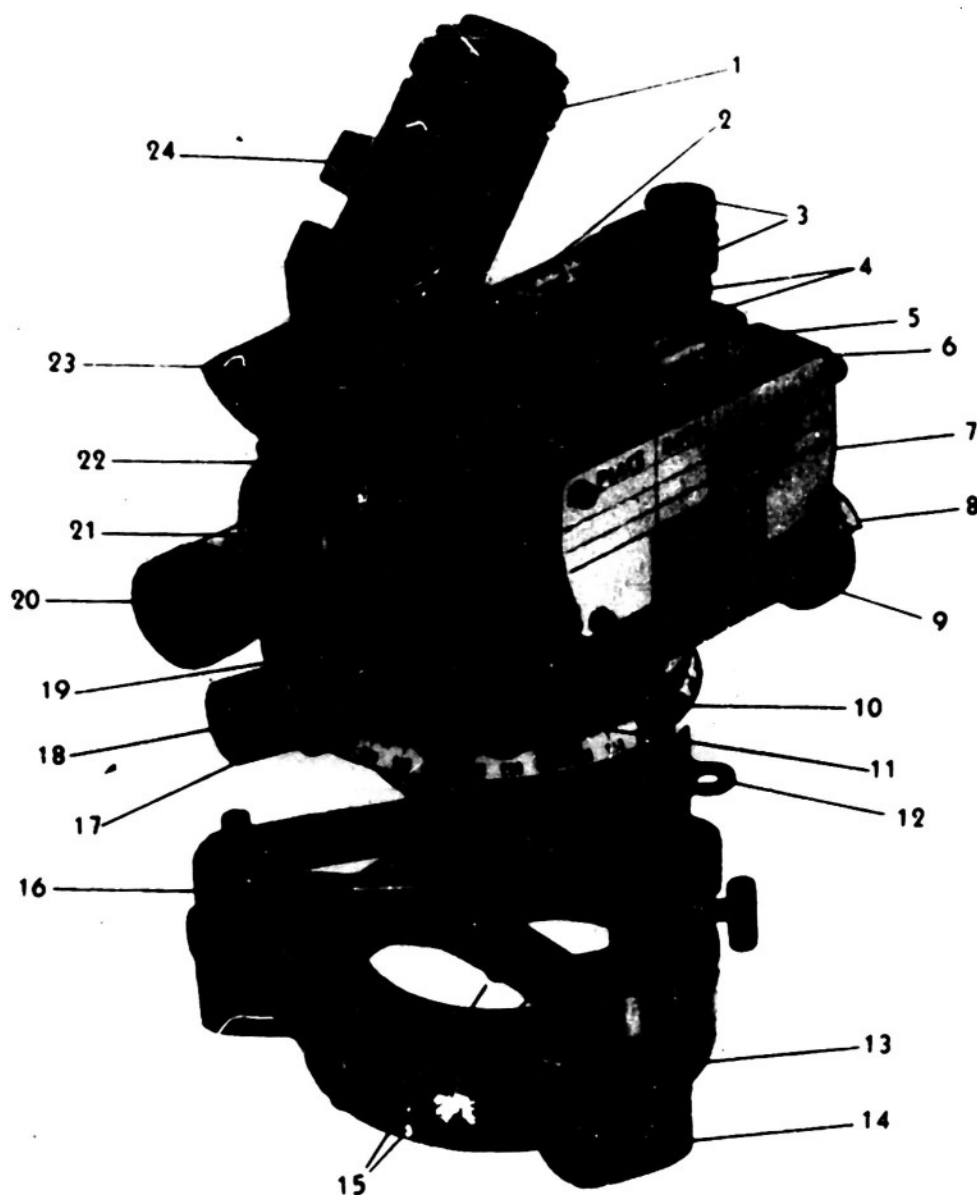


FIG. 2

KEY TO FIGURE 2

- |                                       |  |
|---------------------------------------|--|
| 1. Securing ring, eyepiece cell       | 13. Footscrews                               |
| 2. Bubble, spirit AE, telescope       | 14. Base, tribrach                           |
| 3. Capstan nuts, adjusting bubble     | 15. Screws, securing lug                     |
| 4. Open sights                        | 16. Tribrach                                 |
| 5. Bubble, spirit B                   | 17. Index, azimuth scale                     |
| 6. Housing, elevating arc             | 18. Fluted head, worm gear, No. 1            |
| 7. Recording plate, compass deviation | 19. Plunger, compass release                 |
| 8. Micro drum                         | 20. Knurled head, worm gear, No. 2           |
| 9. Scale plate, elevation             | 21. Spindle cap, adjusting compass variation |
| 10. Scale azimuth                     | 22. Body level, circular, Mk. 2              |
| 11. Knurled head, elevation           | 23. Rainshade                                |
| 12. Securing lugs, base supporting    | 24. Graticule window, illuminating           |

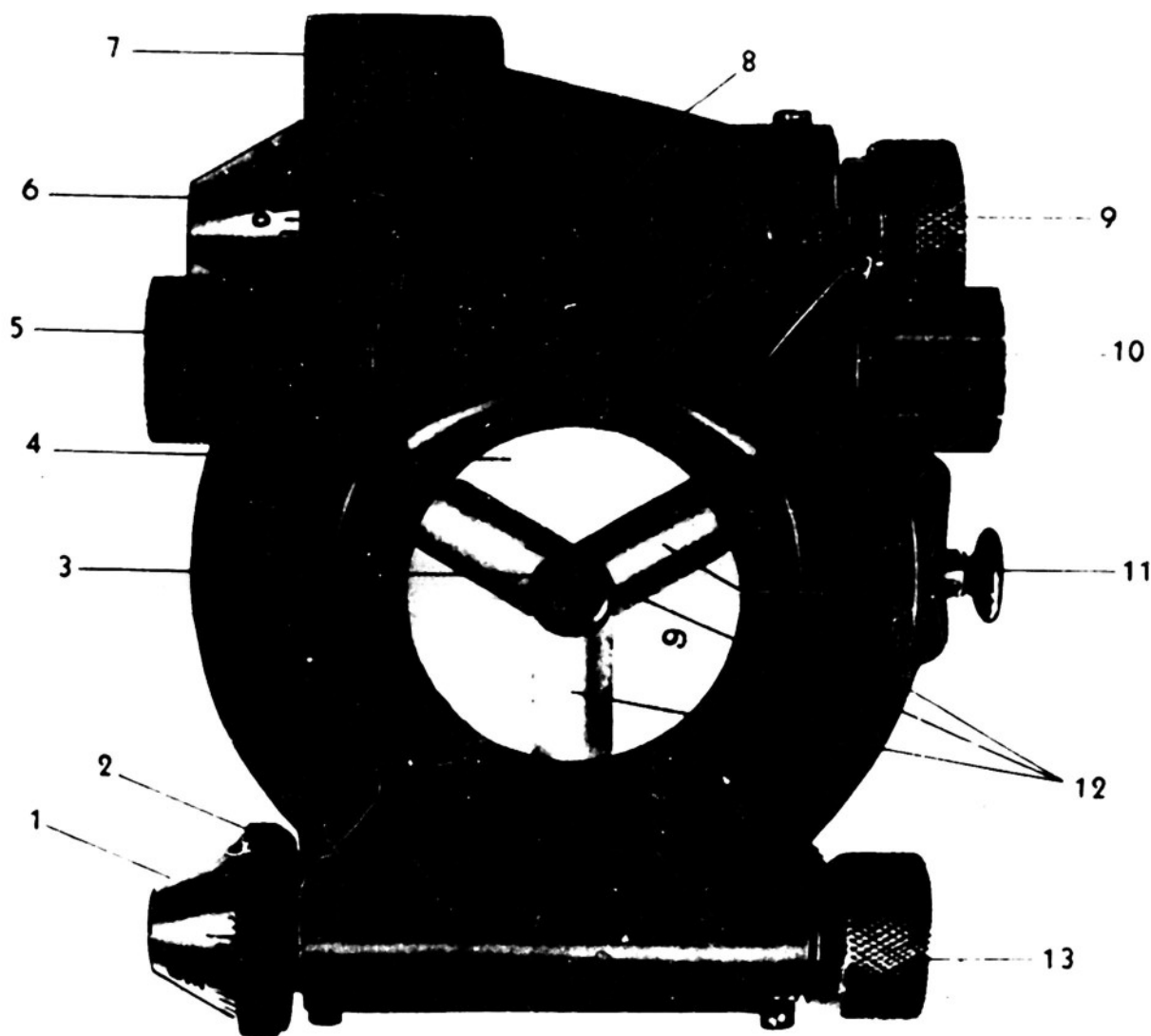


FIG. 3

KEY TO FIGURE 3

- |  |   |
|--|---|
| 1. Micro drum, gear worm, No. 3          | 8. Lever, quick release, gear worm No. 1  |
| 2. Index ring, micro drum                | 9. Knurled head, gear worm No. 2          |
| 3. Hole securing base supporting         | 10. Fluted head (right) gear worm No. 1   |
| 4. Base                                  | 11. Plunger, compass release              |
| 5. Fluted head (left) gear worm No. 1    | 12. Grooves, positioning, base supporting |
| 6. Micro drum, gear worm No. 2           | 13. Knurled head, gear worm No. 3         |
| 7. Lever, quick release, gear worm No. 2 |   |

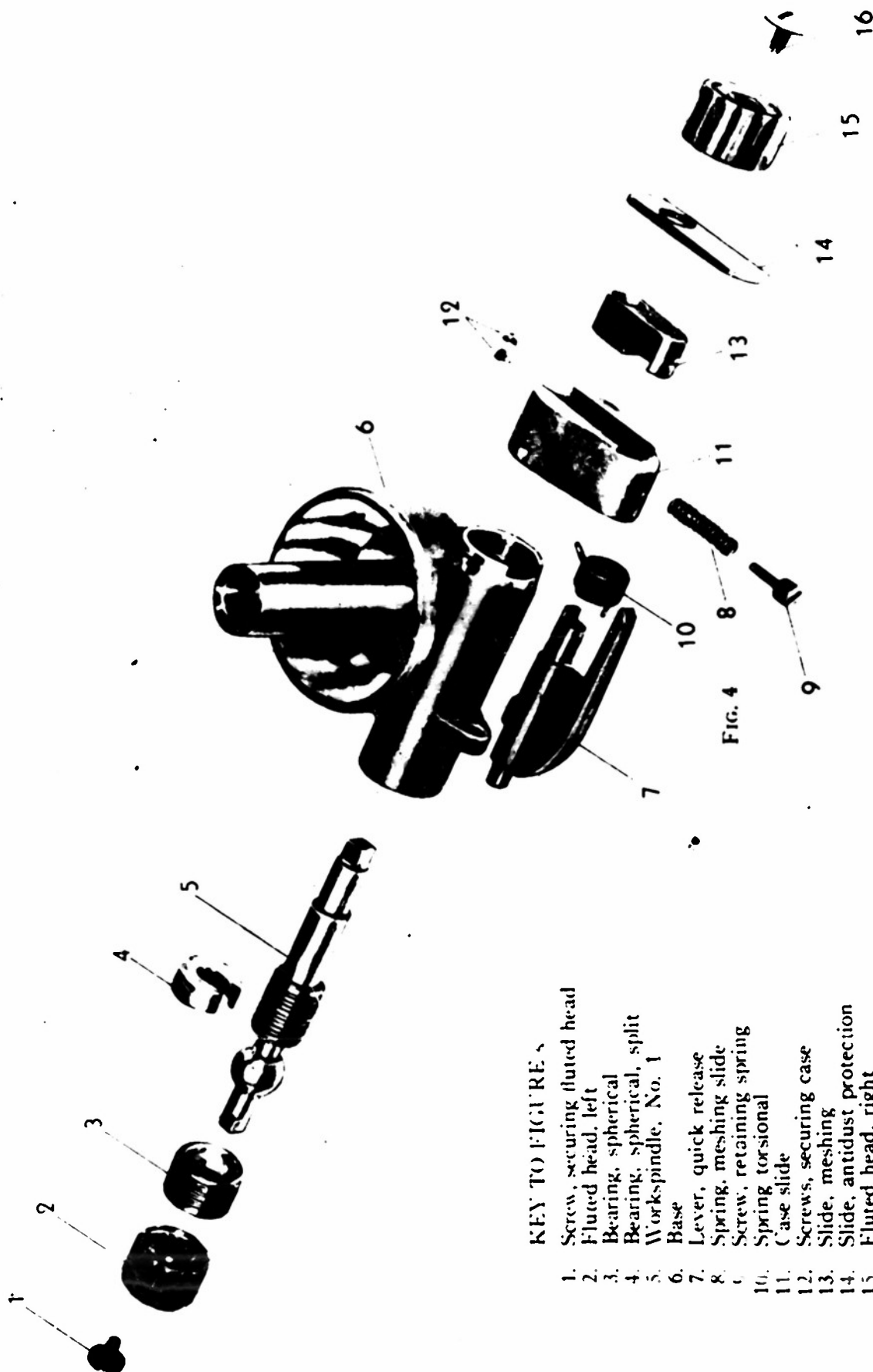


FIG. 4

KEY TO FIGURE 4

1. Screw, securing fluted head
2. Fluted head, left
3. Bearing, spherical
4. Bearing, spherical, split
5. Workspindle, No. 1
6. Base
7. Lever, quick release
8. Spring, meshing slide
9. Screw, retaining spring
10. Spring torsional
11. Case slide
12. Screws, securing case
13. Slide, meshing
14. Slide, antiaust protection
15. Fluted head, right
16. Screw, securing fluted head

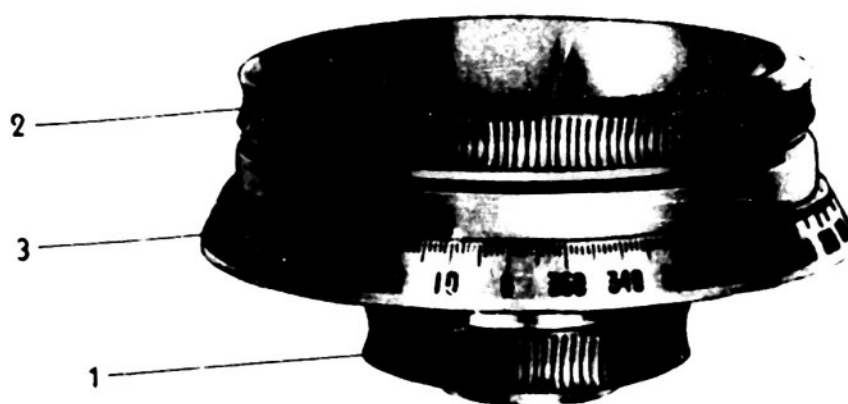


FIG. 5

KEY TO FIGURE 5

1. Worm wheel No. 1
2. Worm wheel No. 2
3. Azimuth scale

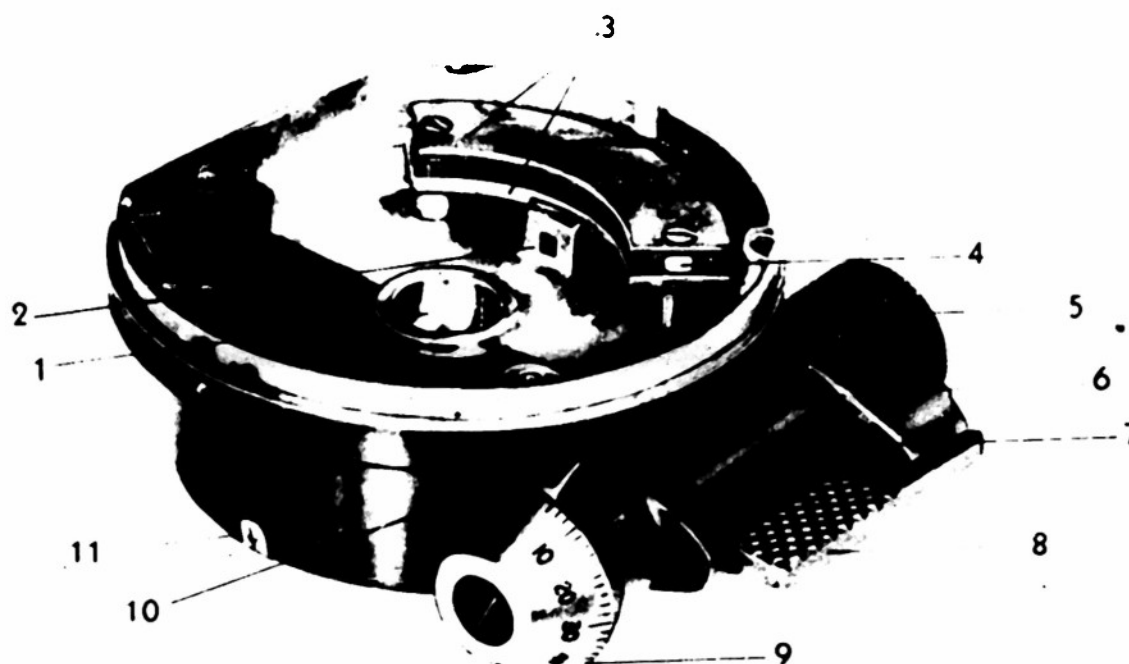
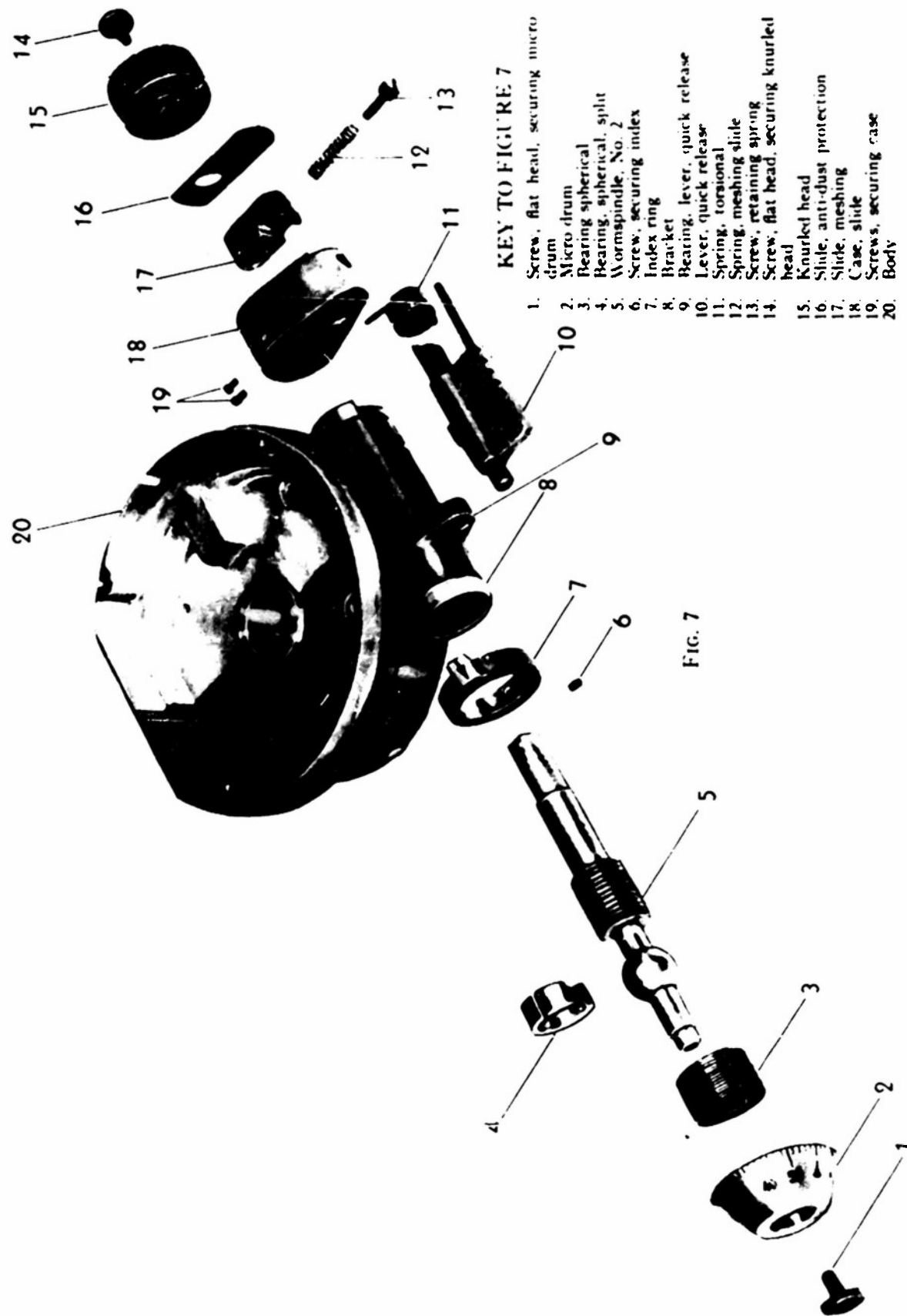


FIG. 6

KEY TO FIGURE 6

- |                                    |                                |
|------------------------------------|--------------------------------|
| 1. Socket, vertical pivot          | 7. Spring, torsional           |
| 2. Socket, compass release plunger | 8. Lever, quick release        |
| 3. Damping plates                  | 9. Micro drum, gear worm No. 2 |
| 4. Spacer, damping plates          | 10. Index, micro drum          |
| 5. Knurled head, gear worm No. 2   | 11. Index, azimuth scale       |
| 6. Case slide                      |                                |





KEY TO FIGURE 8

1. Locking nut, adjusting screw
2. Adjusting screw, compass pivot
3. Base, compass pivot
4. Pivot, compass needle
5. Compass needle
6. Ring, retaining, compass correction arc
7. Screws securing ring
8. Compass correction arc
- 8a. Vernier, compass scale
9. Plate, compass scale
10. Screws, securing compass scale
11. Fibre pad
12. Screws, securing fibre block
13. Screws, securing damping plates
14. Spacers, damping plates
15. Damping plates
16. Screw, securing slide
17. Plunger, compass release
18. Spring, actuating plunger
19. Slide, compass clamping
20. Pivot block, compass needle.

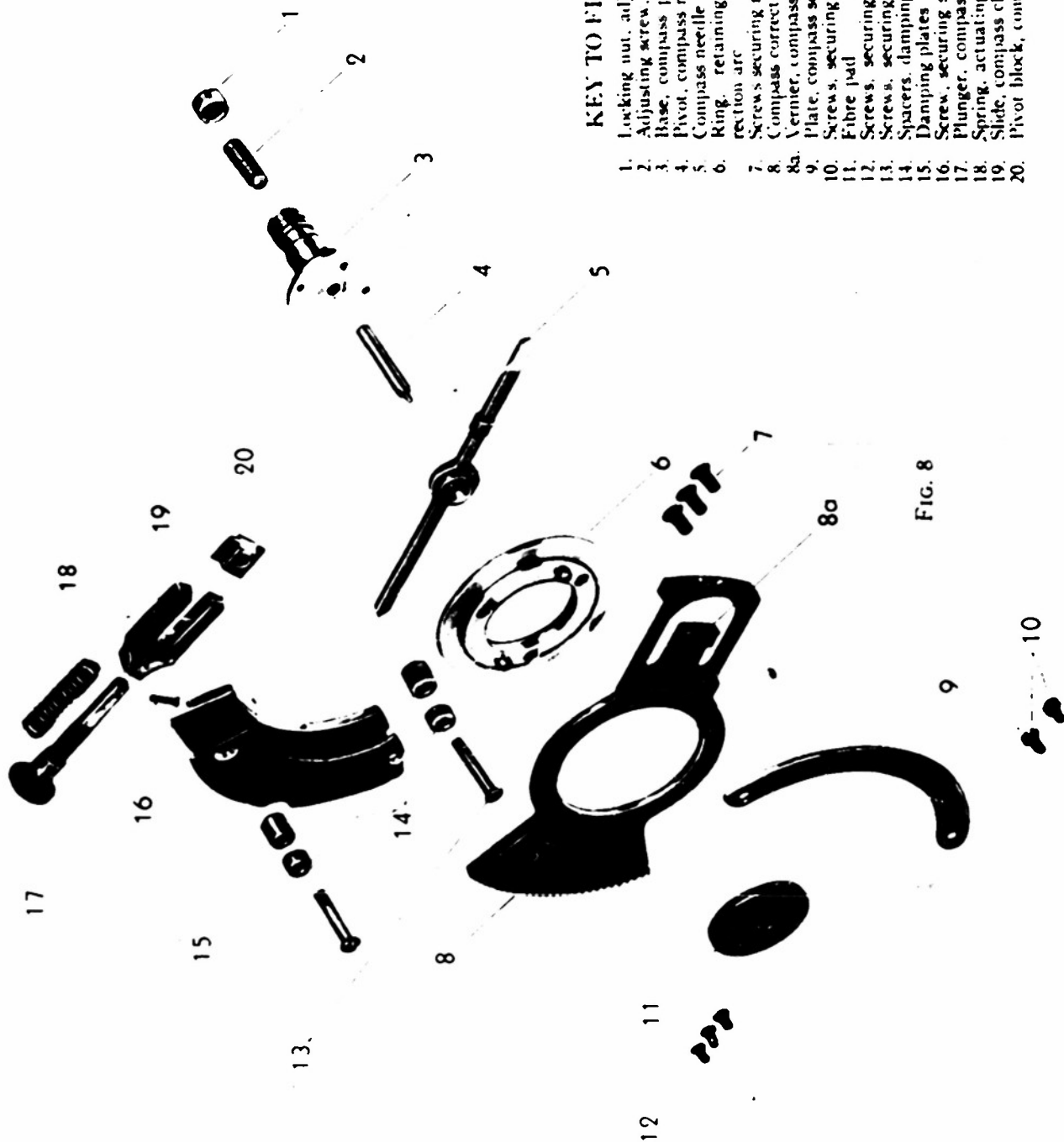


FIG. 8

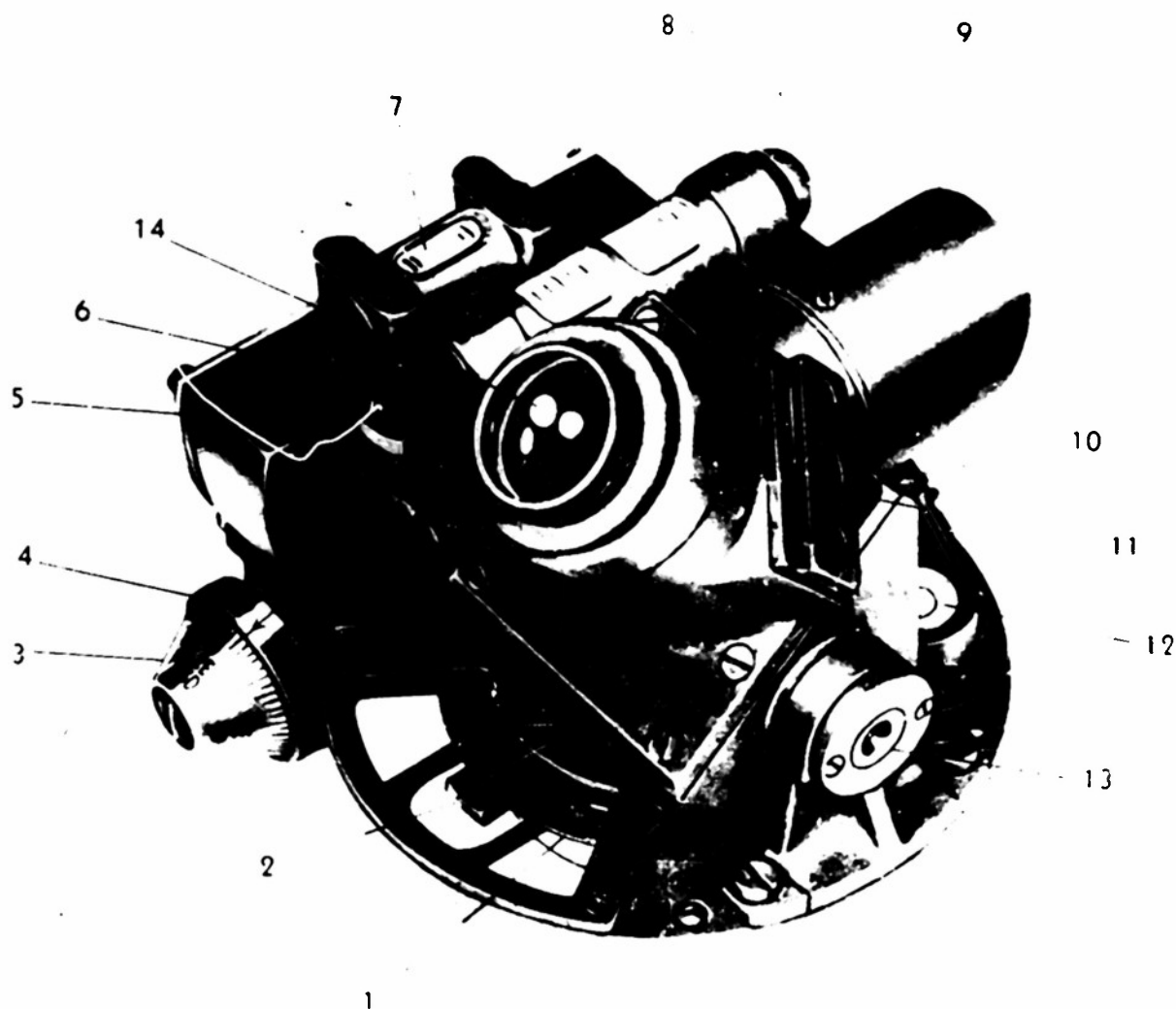


FIG. 9

KEY TO FIGURE 9

- |                           |  |
|---------------------------|--|
| 1. Plate, compass scale   | 8. Bubble, spirit A; telescope               |
| 2. Vernier, compass scale | 9. Telescope                                 |
| 3. Micro drum             | 10. Spindle cap, adjusting compass variation |
| 4. Index ring, adjustable | 11. Graticule window, illuminating           |
| 5. Housing, elevating arc | 12. Body bubble, Mk. 2                       |
| 6. Nut, adjusting bubble  | 13. Bearing, right, trunnion                 |
| 7. Bubble, spirit B       | 14. Locks                                    |